Interannual-to-decadal Variation of Tropical-subtropical Exchange in the Pacific Ocean: Boundary Versus Interior Pathways

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Tropical-subtropical exchange of water masses is considered to be important to interannual-to-decadal variability in the tropical Pacific. On average, the exchange is accomplished by a shallow (< 400 m) meridional circulation which connects the equatorial upwelling, poleward transport of surface Ekman flow, and equatorward transport of pycnocline waters originating from the subtropics. Pycnocline waters arrive at the tropics via western-boundary and interior pathways. It is well-established that, on average, the two pathways re-enforces the net exchange. However, less is known about their relative role on interannual-to-decadal time scales and the underlying physical processes. In this study, we address these issues using sea level measurements obtained by the TOPEX/Poseidon satellite altimter and circulation estimated by the Consortium for Estimating the Circulation and Climate of the Ocean (ECCO; http://www.ecco-group.org). Variation of pycnocline transport via the boundary is found to be (1) anti-correlated to and (2) smaller in magnitude than that of the interior. These features are attributed to the combined effect of two different forcing mechanisms: (1) the variation of local wind stress curl changes the strength of horizontal circulation and results in variation of boundary flow that is opposite in direction and comparable in magnitude to that of interior flow; (2) the variation of equatorial zonal wind stress which affects the strength of meridional circulation with net pycnocline flow opposing the surface Ekman flow. Due to the partial compensation by boundary flow, the convergence of pycnocline waters into the tropics is about 50% of that inferred from interior pycnocline flow alone. The net pycnocline transport reflects ENSO forcing on interannual time scales. There is less equatorward intrusion of pycnocline water in the 1990s than in the 1980s, consistent with recent observation. In the North Pacific, variability of interior pycnocline transport is larger than that through the boundary. This is different from the time mean where the interior transport is substantially smaller than that through the boundary.